THE SUSTAINABLE DEVELOPMENT GOALS CENTER FOR AFRICA

GUIDELINE FOR SCHOOL - FOCUSED RAINWATER HARVESTING

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Preamble

The Sustainable Development Goals Center for Africa (SDGCA) is an autonomous not-for-profit international organization that supports citizens, governments, civil society, businesses and academic institutions to accelerate progress towards achieving Africa's Sustainable Development Goals (SDGs).

African leaders took decisive action after the United Nations General Assembly adopted a new sustainable development agenda in September 2015. They established the SDG Center for Africa as a home-grown African institution committed to championing the implementation of the SDGs in line with the principles of the African Union’s 2063 Agenda. This alignment reassures the audience of the Center's commitment to African development principles.

The Sustainable Development Goals Center for Africa (SDGCA) has its headquarters in Kigali, Rwanda, and a Sub-Regional Centre in Lusaka, Zambia. The SDGCA aims to continue Africa's progress with the Millennium Development Goals by uniting people, ideas, and innovations to work towards a more sustainable future collectively.

In Sub-Saharan Africa, insufficient water supply in schools affects the availability of drinking water, hygiene and sanitation facilities. Many schools in rural and informal urban areas have no conventional water supply systems that meet the basic standards of safe drinking water. The situation leads to the spread of water-borne diseases such as cholera, typhoid fever, hepatitis, and giardiasis. Against this background, the SDGCA embarked on this school-focused rainwater harvesting guideline.

The school-focused rainwater harvesting guideline enables schools to collect, store, and utilize rainwater for various purposes such as sanitation, irrigation of school gardens, and drinking after proper filtration and treatment. This additional water source promotes self-sufficiency and sustainability in school water supply, leading to reduced demand for municipal water and lower water bills.

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1. Introduction:

The SDG Center for Africa (SDGCA), established in 2015 on the margins of the UN General Assembly and started operation in September 2016, is a not-for-profit international organization supporting African nations in implementing the UN 2030 agenda of the SDGs. The Center aims to ensure appropriate knowledge and information availability and use in African countries' water and sanitation sector. Providing technical support to nation-states, disseminating technologies, and introducing innovations are among the Center's priority areas. Against this background, the Center has initiated the development of this school-focused rainwater harvesting guideline.

Rainwater harvesting aims to allow schools to capture, store, and use rainwater for supplementary uses, including sanitation and irrigation of school gardens. This guideline provides information, experiences or practices, directives, and recommendations for installing rainwater harvesting schemes in schools. It is prepared to help urban schools that lack access to conventional water supply systems and rural schools located in areas without conventional or natural (rivers, springs, boreholes) water supply systems. All these schools have no means to meet their basic needs and achieve the desired SDG 6 targets. Even rural schools that depend on unimproved natural water sources can benefit from rainwater harvesting schemes if the quality standards are maintained. This guideline can help such schools to install rainwater harvesting schemes and ensure they meet relevant standards or regulations.

There are five main types of water harvesting systems: rooftop harvesting systems with storage in either surface or underground tanks; runoff harvesting from open surfaces, paths, roads, and rocks, with storage in ponds, underground tanks, or other structures; flood flow harvesting from valleys, gullies, and temporary streams, with storage in ponds, weirs, and small dams; flood flow harvesting from ephemeral watercourses, with storage within sand formations as sub-surface or sand dams; and runoff harvesting and diversion from other sources, with storage within the soil profile.[1] This guideline is for rainwater harvesting schemes that collect precipitation primarily from rooftops. Rooftop rainwater harvesting provides water for drinking, domestic use, livestock, small irrigation, and a way to replenish groundwater levels. The guideline does not include stormwater harvesting, another means of rainwater harvesting. Strom water harvesting schemes collect runoffs from creeks, gullies, ephemeral streams, and underground conveyances, including catchment areas from developed surfaces, such as roads or parking lots, or other urban environments such as parks, gardens and playing fields.[2]

2. Background:

Rainwater harvesting is one of the simplest and oldest methods of household water supply. In many places worldwide, including Africa, it has been used for centuries to collect and store water for various uses. In recent years, there has been an increasing interest in rainwater harvesting to address water scarcity, particularly in urban areas. Governments, NGOs, and communities increasingly implement rainwater harvesting schemes to supplement conventional water supply systems and ensure access to clean and reliable water. Rainwater harvesting is a sustainable and eco-friendly alternative to surface water and groundwater sources, which can be costly and environmentally destructive if not properly designed. Overall, rainwater harvesting at the household level has a long and rich history and continues to be an

[1] https://apps.worldagroforestry.org/downloads/Publications/PDFS/WP15616.pdf
[2] https://en.wikipedia.org/wiki/Stormwater_harvesting

important solution to water scarcity in many parts of the world. Apart from households, there are trends of expanding rainwater harvesting schemes to different institutions like schools, health facilities, prisons, and community centres.

Some examples include the following;

In collaboration with the district office, WaterAid Rwanda established a school-based rainwater harvesting infrastructure in Nyagatare District, Rwanda.[3] These rainwater harvesting reservoirs were built in the schools that lack access to water from the main pipeline. The rainwater storage tanks have a capacity of up to 90,000 litres. At 20 litres per capita per day consumption rate as a supplementary water source, the storage can serve up to 9,000 students daily (our estimation). The students commended the construction of the rainwater harvesting schemes to solve their water shortage problems.

Faced with rising sea levels and intruding saltwater, a school in Tanzania is harvesting rainwater to provide its students and community with water for drinking and irrigation. Before the rainwater harvesting project, students and community farmers spent precious time travelling long distances to collect drinking water. Thanks to the project, students have more time to focus on schoolwork, and farmers have ample time and water to tend to their crops.[4]

UN-HABITAT and local NGO, Ethiopian Rainwater Harvesting Association (ERI-IA), and the government entity known as Zanzibar Water Authority (ZAWA), as part of the Water for African Cities program, formed partnerships for the planning and the implementation of a rainwater harvesting pilot project in Ethiopia and Zanzibar respectively. Rainwater harvesting schemes were demonstrated in 13 schools, four community centers and two prisons, reaching over 22,000 beneficiaries. It was found that the promotion of rainwater in schools and similar institutions can help to reduce costs either through the reduction of the values of water bills or by saving electric power that is used to pump water from wells. Providing schools with rainwater harvesting schemes improves hygiene and sanitation conditions, and the implementation through schools has proved effective in reaching the community at large (here)[5].

3. Challenges

Water shortages in African schools can significantly impact the students, teachers, and the learning environment. Lack of adequate drinking water in schools affects the hygiene and sanitation facilities and leads to the spread of water-borne diseases such as cholera, typhoid fever, hepatitis, and giardiasis. The water shortage in the schools can lead to dehydration. The student's illness and dehydration result in absenteeism and lack of concentration of students in the classrooms, which are factors of poor academic performance and reduction in the quality of education. Additionally, the lack of water can make it challenging for schools to practice school agriculture and maintain gardens and green spaces. The failure to practice school agriculture can impact the school's advantage of producing vegetables and other food products and limit the opportunities for outdoor learning activities. Overall, water shortages can harm

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[3] https://www.topafricanews.com/2022/05/10/nyagatare-students-commend-the-construction-of-school-based-rainwater-harvesting-facilities/

[4] https://gca.org/video/rainwater-harvesting-in-a-school-in-tanzania-state-trends-in-adaptation/

[5] The article's original author is Tekalign Tsige Sahilu, also the author of this guideline. The article's title was "Falling Blue Gold Helps Urban Africa's Water Supply". It was published (http://www.mydigitalpublication.com/publication) under Water and Wastewater International, October/November 2011, Vol 26 Issues.

African school students' health, well-being, and academic outcomes and impact achieving the SDG targets of ensuring quality education by 2030.

4. Benefits:

Many schools in rural and slum urban areas in Africa have no access to drinking water. There are no conventional water supply networks, even natural streams or other water sources, in many of the schools. For such schools, the implementation of rainwater harvesting has several benefits. Rainwater can be a supplementary water source for the school and can be used for sanitation (toilets and hand washing), school agriculture, irrigation, and other purposes like cooking meals. Without an alternative drinking water supply, rainwater can be used for drinking after adequate filtration and treatment are done. Rainwater harvesting can help schools become more self-sufficient and sustainable regarding water supply and contribute to saving water bills by reducing the demand for municipal water. It can help improve the school environment by supporting the growth of school gardens and green spaces. It can also serve as a valuable educational tool, teaching students the importance of water conservation and sustainable practices.

5. Technology Choice:

There are different options for rainwater harvesting in schools. One option is to use the roofs of school buildings as catchment areas. The harvested rainwater can then be stored in polyethene plastic or roto tanks, metallic tanks, masonry tanks, or ferrocement tanks. The location of these tanks can be underground or above-ground water tanks, which can be used for irrigation and other purposes. The choice of a suitable tank size depends on several factors: the availability of funds, the amount of water required by the school between rain seasons (water demand), the roof catchment area, the total seasonal rainfall, and the available materials and technology. It's important to note that there is no need to have a tank capacity equal to the annual run-off volume from the roof catchment, as water is being consumed on a daily basis.[6]

Collecting and storing rainwater from rooftops is a great way to supplement the school's water supply. In addition to providing water, these efficient systems can help schools save water and reduce their water bills. Here are some steps to follow when installing rainwater harvesting schemes. Following these steps, a given school can collect and store rainwater from the rooftop and use it for various purposes, including watering the garden.

i. Consult the school community and brief them about the benefits of rainwater harvesting for the school.
ii. Develop adequate guidelines on the construction and installation of the rainwater system in the school.
iii. Establish a school committee to oversee and participate in installing the rainwater harvesting infrastructure in the school.
iv. Select the appropriate catchment area by identifying the suitable roof to capture and collect enough rainwater. Also, consider the appropriate distance between the ground and the roof to enable the installation of the above-ground storage tank.

[6] Wanyonyi, J. M. 2004. Improving rainwater quality for domestic use. In: Mloza-Banda, H. R. Proceedings of the Rainwater Harvesting Stakeholders' Symposium, December 18-19, 2003, Lilongwe, Malawi.

v. Install gutters: Ensure and inspect the gutters are properly installed and the right size for the roof.
vi. Install a downspout: Ensure that the downspout is properly installed and connected to the gutters to direct the water collected to the storage tank.
vii. Choose a storage tank of the right size for the school's needs and make it of appropriate material for the school's climate among the different types of storage tanks (plastic, concrete, metal).
viii. Install a filter to remove debris and other contaminants before entering the storage tank to ensure the water is clean and safe.
ix. Incorporate first-flus diverters to maintain the quality of the water in the tank; a pump, hard or concrete ground below the taps and channels to drain off excess water are required to minimize the creation of muddy conditions and soil erosion.
x. Install an overflow system to divert excess water from the storage tank to prevent the tank from overflowing and causing damage to the property.
xi. To ensure the proper functioning of the rainwater harvesting system, the established school committee should be given the responsibility of conducting regular maintenance, including cleaning the storage tanks, gutters and filters, checking for leaks, and monitoring the water level in the tank**.**

6. Activities:

6.1 Design rainwater harvesting for the school.

When designing rainwater harvesting systems for schools, several key considerations should be taken into account. These include:

- *Catchment area:* The size and type of catchment area will depend on the amount of rainfall the area receives and the size of the school. Roofs of buildings are often used as catchment areas, but other options may include rocky outcrops, hillsides, and patios. The catchment area should be clean and debris-free to prevent contamination of the collected water.

- *Storage capacity:* The size of the storage tank will depend on the size of the catchment area and the amount of rainfall the area receives. The tank should be large enough to store sufficient water for the school's needs but not so large that it becomes difficult to maintain and keep clean.

- *Water quality:* The collected rainwater should be treated to ensure it is safe for its intended use. This may include filtration, chlorination, or other treatment methods. Regular water quality testing should be conducted to ensure that it meets the required standards.

- *Delivery system:* The collected rainwater can be delivered to the school garden or other areas using various methods, including buckets, watering cans, treadle pumps, motor pumps, or solar-powered electric pumps. The delivery system should be efficient and easy to operate.

- *Maintenance:* Regular maintenance of the rainwater harvesting system is essential to ensure that it continues to function effectively. This may include cleaning the catchment area and storage tank, checking the water quality, and repairing any leaks or damage.

By considering these design considerations, schools can create effective and sustainable rainwater harvesting systems that provide a reliable water source for their needs.

Rainwater collection and storage

A rainwater collection and storage system consists of a catchment area (usually the roof of a permanent structure), guttering channels, and downpipes that direct rainwater into a water collection vessel (e.g. storage tank, pot, bucket).

Though rainwater sources are generally considered to be of a higher quality than surface water sources, appropriate disinfection/treatment of rainwater is recommended where there is a risk of contamination.

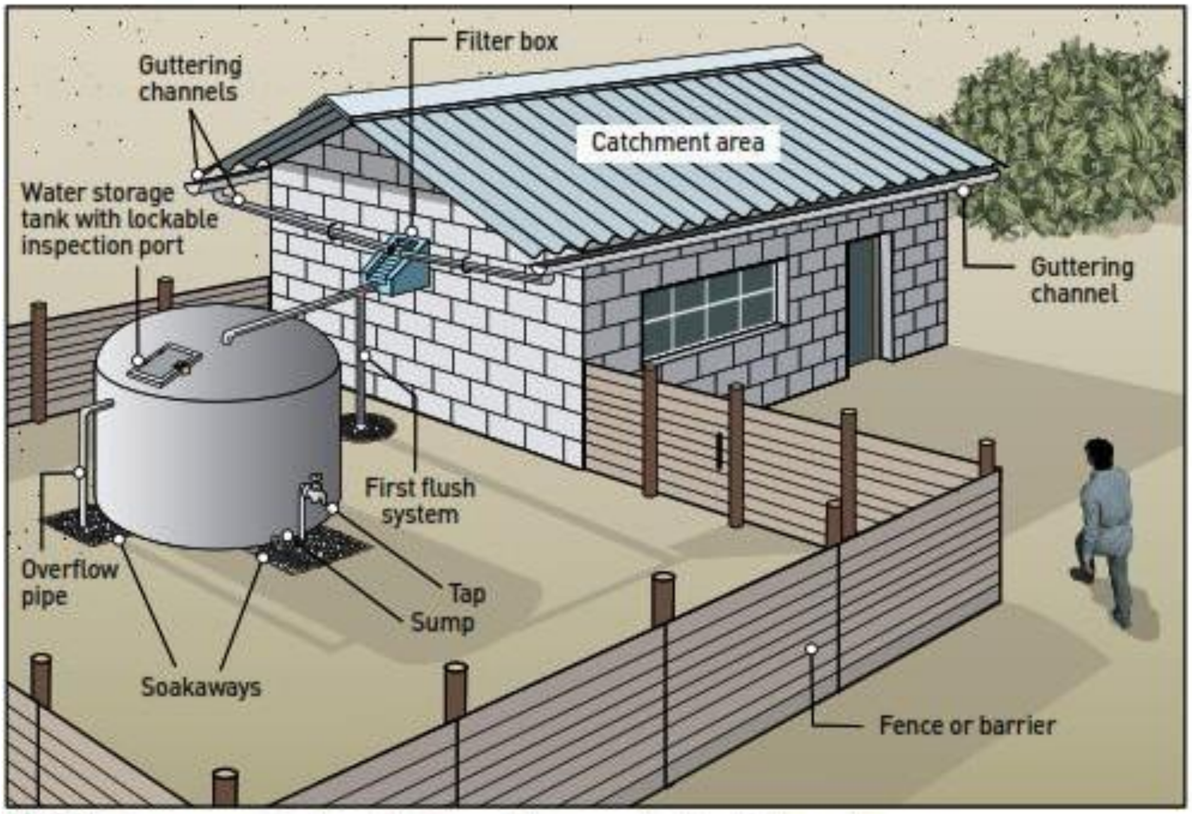

Figure 1 A common rainwater collection and storage system for drinking-water

6.2 Site selection (school selection)

When choosing schools for rainwater harvesting, it's important to consider several criteria. First, we must consider the school's location and the rainfall amount it receives. Schools in regions with low rainfall may not benefit significantly from rainwater harvesting, and alternative water sources may need to be considered. Second, we need to determine the size and type of catchment area available, as this will affect the amount of rainwater that can be collected. Third, we must assess the school's water needs to determine the required storage tank size. Fourth, we need to ensure that the school has the capacity to maintain and operate the rainwater harvesting system. Finally, we need to study the potential impact of rainwater harvesting on the school's environment and surrounding communities. By considering these criteria, schools can select appropriate rainwater harvesting systems that meet their needs and contribute to a sustainable water supply.

6.3 Training and Capacity Building

Training and capacity building are essential for successfully operating and managing school rainwater harvesting systems. It is crucial to ensure that school staff and students are familiar with the operation and maintenance of the systems to ensure their proper functioning and longevity.

Training programs should include the following:

- System design and installation: Participants should be trained to design and install rainwater harvesting systems, including catchment areas, storage tanks, and delivery systems. This will ensure that the systems are installed correctly and function efficiently.
- Water quality testing: Participants should be trained on how to test the quality of the collected rainwater to ensure that it is safe for its intended use. This will help to prevent the spread of water-borne diseases and ensure that the water is suitable for irrigation and other purposes.
- Maintenance and repair: Participants should be trained to maintain and repair rainwater harvesting systems, including cleaning the storage tanks, fixing leaks, and replacing damaged components. This will ensure that the systems function efficiently and last longer.
- Record keeping: Participants should be trained to keep records of water usage, maintenance activities, and repairs. This will help track the systems' performance and identify any issues that may arise.

6.4 Operation and Maintenance

Effective operation and maintenance of the rainwater harvesting schemes need adequate attention. Regular maintenance and monitoring of rainwater harvesting schemes are critical to ensuring their long-term sustainability and effectiveness in providing clean and reliable water for schools. Upon the completion of the installation of the rainwater harvesting schemes, the contractor must develop guidelines in a language the school community understands and provide training on operation and maintenance. The following are some key considerations for the operation and maintenance of rainwater harvesting schemes:

i. *Regular cleaning of gutters and downpipes* to prevent blockages and ensure the harvested rainwater is free from debris and pollutants.

ii. *Regular maintenance of the storage tank* to inspect the tank for leaks and cracks, clean the interior of the tank, and ensure that the inlet and outlet pipes are functioning properly.

iii. *Regular water quality testing* to ensure the harvested rainwater is safe for its intended use. Testing should be done periodically to detect any changes in water quality.

iv. *Regular maintenance of the filtration and treatment systems* includes cleaning or replacing filters and ensuring that any treatment systems function properly.

v. *Regular inspection of the system* involves checking for any damage or wear and tear in the system, such as cracks in the pipes or damage to the storage tank.

vi. *Regular water usage monitoring* is necessary to ensure that the system meets the school's water needs and detects any leaks or other issues.

vii. *Regular training and awareness-raising* to ensure that the school staff and students know how to use the system correctly and promote the importance of water conservation.

7. Financing

Classifying the capital and operation & maintenance costs of schools' rainwater harvesting schemes is important. The capital side is relatively high, and many schools may not have the budget to cover it. It is hardly possible to expect the government budget to cover the costs of rainwater harvesting schemes. Consequently, all feasible financing sources need to be examined. There is a need to consider the traditional and new financing systems. Continuing mobilizing bilateral and multilateral aid or grants is very important. Developing project proposals and approaching donors that support African schools' WASH programmes is one of the areas in which resources can be mobilized. Schools can organize fundraising events and invite all stakeholders to support the initiatives. Local communities place education among the highest priorities, so school-focused rainwater harvesting can be considered a collective scheme that communities can invest in. However, government subsidies and/or donor grants are helpful in lessening the burden on the community. Wherever possible, the community's in-kind contributions (labour and material) should be accounted for in the capital cost financing of the infrastructures.

The operation and maintenance costs of the schemes can be planned systematically. Collecting an estimated amount from each student every year during registration is easier. Considering the parents' ability to pay is crucial. Some parents may have more ability to pay than others. Under such circumstances, applying cross-subsidy by allocating different fees among the families is useful. This strategy needs a consensus among the school community.

8. Key Considerations:

School selection: The location of the school is an important factor to consider. The site should be able to collect enough rainwater, and the catchment area should be free from obstructions like trees and buildings.

Design: The design should consider the school building and environment, such as safety, proximity, and accessibility for all users, including persons with disabilities.

Installation: The system's installation needs to consider the standard and quality of materials, and the cost of installing and maintaining the rainwater harvesting system should be assessed to ensure it is cost-effective for the school.

Water quality: The quality of the harvested rainwater should be monitored regularly to ensure it is safe for drinking and other uses. Water treatment systems may be required to remove impurities and contaminants.

Maintenance: the rainwater harvesting system should be maintained and cleaned regularly to prevent the buildup of sediment, debris, and microbial growth.

Training & Capacity Building should be conducted to ensure that school staff and students have the necessary skills and knowledge to operate and manage rainwater harvesting systems and that these systems function efficiently and contribute to school staff and students' health, well-being, and academic outcomes.

Financing: hybrid financing consisting of subsidies, grants, and community contributions need to be explored to cover the capital costs of the rainwater harvesting schemes.

9. Best Practices:

9.1 Rooftop Rainwater Harvesting Practices in Uganda

The UNEP Copenhagen Climate Centre, through the Technology, Markets, and Investment for Low Carbon and Climate Resilient Development (TEMARIN) Project, has been focusing on rooftop rainwater harvesting (RRWH) in Uganda. With an annual rainfall ranging from 500 to 1200 mm, Uganda is well-suited for RRWH to provide clean water in rural areas. Government and donor-funded initiatives have equipped many schools, hospitals, and public institutions with RRWH units to demonstrate their application. However, financial constraints and limited cultural awareness have hindered widespread adoption of these systems.

RRWH technology requires a few components to be operational. It collects water from roof surfaces and directs it into a storage container for various uses that can enhance local livelihoods. To optimize performance, the main components of RRWH units include a roof surface, gutters, pipes, a storage tank, filters, waterproofing agents, and tap fittings. Additionally, first-flush diverters, a pump, hard or concrete ground below the taps, and channels to drain excess water are necessary to prevent muddy conditions and soil erosion. Research indicates that hard roof surfaces are the most efficient for collecting rainwater. Such roofs are present on 70% of houses in Uganda, including approximately 65% of buildings in rural areas.[7] However, assessing the average roof size is challenging in Uganda, as sizes vary significantly from less than 10 m^2 to more than 80 m^2.[8]

The storage tank is a vital part of RRWH technology. These tanks can be pre-made or custom-built and can be placed on the surface, underground, or partially buried. They are available in materials such as plastic, mortar, polyfibre, tarpaulin, and corrugated iron. For a rural household of six people, a tank capacity of over 10 m^3 is ideal, ensuring a year-round supply in regions with bimodal rainfall patterns.[9]

Rooftop runoff can quickly cause soil erosion, jeopardizing house structures and residents' livelihoods. Properly installed RRWH systems can mitigate this by capturing roof water and channeling excess water away, reducing muddy conditions and potential damage to buildings.

During the Kigezi Diocese Water and Sanitation Project (KDWSP), basic large particle filters were used to enhance RRWH system performance and address contamination risks. These low-cost, mesh coarse leaf filters, often made by users from locally available buckets with holes covered by woven steel mesh, improved to meet the WHO water quality standards. The KDWSP, a major supporter of RWH in South West Uganda, has installed over 800 tanks since the mid-1990s.[10]

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[7] UBOS, (Uganda Bureau of Statistics) (2016). National Population and Housing Census 2014. Main report. Kampala Uganda.

[8] Danert, K., & Motts, N. (2009). Uganda water sector and domestic rainwater harvesting subsector analysis.

[9] Martinson, B., & Thomas, T. (2003). Economically viable domestic roof-water harvesting. In Sustainable environmental sanitation and water services (pp. 281-284). WEDC.

[10] https://iwaponline.com/washdev/article/10/3/549/76069/Maintenance-practices-and-water-quality-from

9.2 Rainwater Practices in Kenya

In Makueni County in Kenya, communities commonly use rooftop rainwater harvesting with gutter-to-tank systems. This method has proven reliable, especially for households with substantial rainwater harvesting systems. Most households lack adequate capacity for their water storage tanks. Over 60% of rainwater storage facilities have a capacity of less than 200 liters, insufficient to hold enough water throughout the year. In contrast, the 40% of households that have invested in larger systems, with capacities ranging from 1 to 10 m^3, rarely experience water shortages or waterborne diseases. Rooftop RWH technology, yielding high-quality water, is mostly implemented at homes and schools.[11]

Ferrocement tanks are the most popular for construction due to their affordability and quality, with successful examples found throughout Kenya. These tanks began gaining popularity in the 1980s and 1990s. However, as Nissen-Petersen[12] noted, many initial tanks faced issues due to careless construction with poor sand and inadequate curing, resulting in porous walls prone to seepage. Proper construction is essential for their longevity. Rainwater harvesting tanks are now widespread across the country, gaining popularity in both urban and rural areas. Several private companies in Kenya, including Kentainers, Polytanks, and Roto Moulders Limited, manufacture plastic tanks most of which are circular, enclosed, and come in 5 m^3 or 10 m^3 sizes.[13]

Figure 2: Showing a rooftop RWHS whereby rain is collected from two sides of the roof and directed through gutters to the ferro-cement tank in Kenya (Source: RWH Inventory of Kenya)

[11] https://www.researchinventy.com/papers/v5i2/F52039049.pdf

[12] Nissen-Petersen E. 2007. Water from Roofs: A Handbook for Technicians and Builders on Survey Design, Construction, and Maintenance of Roof Catchments.

[13] https://www.researchgate.net/publication/265842519_Rainwater_Harvesting_Inventory_of_Kenya_An_overview_of_techniques_sustainability_factor_and_stakeholders

9.3 Rainwater Practices in Rwanda

In Rwanda, the Rwanda Water Forestry Authority (RWFA), Centre for Science and Environment (CSE) alumni, and WaterAid Rwanda have collaborated on rainwater harvesting systems in Kigali. This collaboration includes four schools: GS Kabusunzu Secondary School in Nyarugenge district , Lycée Notre Dame de Cîteaux Secondary School in Nyarugenge district , GS Kagarama Secondary School in Kicukiro district, and GS Akumunigo Secondary School in Nyarugenge district. These schools have implemented design specifications, operational and maintenance practices, and performance monitoring to optimize the success of their rainwater harvesting systems.

Much of the contemporary research on rainwater harvesting in these four schools show that their water supply comes from both the municipal water system (WASAC) and harvested rainwater. The harvested water is used for all purposes except drinking and cooking. At GS Kabusunzu Secondary School, which has the highest number of users standing at 2,848 comprising of both students and staff, needs 1,520 liters of water daily. In order to meet this demand, especially during the dry season (July and August), the school implemented a rainwater harvesting system with nine storage tanks, including plastic. tanks, ferrocement tanks, and an underground plastic-lined tank, with capacities of 5 m^3, 45 m^3, and 500 m^3 respectively.

Figure 3:Shows an underground storage tank with sand filters and an above ground plastic storage tank

GS Kagarama Secondary School also uses both ferrocement and plastic tanks, with the ferrocement tank being underground. Rainwater passes through a two-chamber tank, where the first chamber with size 3.6 m^3 acts as a settler for silt and solid particles, and the second chamber contains 800 kg of sand for filtration. The filtered water is retrieved using a pedal pump. To improve the rainwater harvesting system performance and prevent contamination, a first flush system has been installed to discard the initial rainwater spells. Gutters are also cleaned regularly to prevent clogging, and the support staff has been given the responsibility to handle the system's operation and maintenance. Interestingly, GS Akumunigo Secondary School, which uses both masonry and plastic tanks, cleans the masonry tanks annually and the plastic tanks 4-5 times a year, although accessing the rooftop catchment areas for cleaning continues to remain a challenge.


Figure: Showing a conveyance system along with the first flush. (Source, CSE 2018)

Implementing rainwater harvesting systems has provided significant socio-economic and environmental benefits to these schools. They have significantly reduced their municipal water bills, contributing to the payback of the installed rainwater harvesting systems. The reduced reliance on public water supply has also positively impacted the environment, potentially earning carbon credits for energy conservation. The increased water availability has helped maintain green landscapes year-round, reducing erosion. The acceptance and dissemination of rainwater harvesting concepts among students have increased, with the harvesting practice integrated into the environmental curriculum. At GS Akumunigo Secondary School, in particular, the rainwater harvesting system has made water more accessible for various activities, inspiring neighboring communities to replicate the system in their households.[14]

10. Conclusion

Water scarcity significantly impacts schools in Africa, affecting the quality of education and hindering the achievement of the SDG target of providing quality education for all by 2030. Both rural and peri-urban schools suffer from water shortages. It's crucial to provide training and increase awareness of rainwater harvesting technologies in these schools.

The level of education plays a role in the adoption of rainwater harvesting technologies. Introducing rainwater harvesting into the school curriculum can enhance understanding of these technologies. Additionally, training and capacity building are essential for successfully operating and managing

[14] https://waterportal.rwb.rw/sites/default/files/2019-04/Potential of Rainwater Harvesting in Rwanda report-Final.pdf

school rainwater harvesting systems. It is crucial to ensure that school staff and students are familiar with the operation and maintenance of the systems to ensure their proper functioning and longevity.

The schools need to establish committees that can take training and regularly maintain and monitor rainwater harvesting schemes. These are critical to ensuring long-term sustainability and effectiveness in providing clean and reliable school water. Established school committees should ensure the monitoring and inspection of the infrastructure, including the follow-up of regular maintenance.

It's important to employ skilled artisans to avoid issues stemming from poorly constructed systems, which, unfortunately, are common. Problems with ferrocement water storage tanks often result from low cement concentrations to save costs, insufficient curing time, or a lack of knowledge of proper construction methods. Standardizing or certifying RWH tank construction could mitigate these issues.

Incorporating a 'first flush' system to divert the initial rains of the season away from the tank is crucial for maintaining the quality of tank water and the users' health. Providing technical training on repairing small leaks is important for maintaining long-lasting tanks. For irreparable leaks, inserting a plastic lining in the tank could make otherwise useless tanks productive.

To address the capital and operational costs that hinder the adoption of rainwater harvesting technologies, a hybrid financing mechanism needs to be explored. The financing system can include government subsidies, donor grants, community contributions (in-kind and monetary), as well as fees raised during registration.